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New Projects

Title	Leader	Co-researchers	Grant
Design and Development of an Electrohydrodynamic (EHD) Micropump with a Flow Simulation Study	Assoc. Prof. Ir. Dr. Andrew Ragai Henry Rigit	D.B.L. Bong A. Joseph J. Labadin M.A. Idris (UNITEN) K.C. Lai (UTAR)	MOSTI e-Science (RM 101,100.00)
Design and Development of DNA Sequences Based on Multi-objective Particle Swarm Optimization for DNA Computing	Dr. Mohd Saufee Muhammad	Mdm. Sharifah Masniah Wan Masra Mdm. Kuryati Kipli Nurdiani Zamhari Zuwairie Ibrahim	MOHE FRG (RM 50,000.00)
Theoretical Evaluation of Effect of Opening on Ultimate Load-carrying Capacity of Square Slabs with Fixed Supports	Prof. Dr. Ng Chee Khoon	Dr. Delsye Teo Ching Lee	MOHE FRG (RM 47,232.00)
Self Initialization Network Discovery and Localization Protocol for Underwater Acoustic Network	Dr. Al-Khalid Bin Othman	Dr. Wan Azlan Bin Wan Zainal Abidin Dr. Hushairi Bin Zen Dr. Kismet Anak Hong Ping	MOHE FRG (RM 32,000.00)
A Study to Design an Electrohydrodynamics Micropump for Microelectronics Cooling	Assoc. Prof. Ir. Dr. Andrew Ragai Henry Rigit	Ir. David Bong Boon Liang	MOHE FRG (RM 32,000.00)
Parallel Processing of Time-domain Inverse Scattering Imaging Technique for Breast Tumour Detection	Dr. Kismet Anak Hong Ping	Dr. Wan Azlan Bin Wan Zainal Abidin Dr. Al-Khalid Bin Othman Dr. Thelaha Bin Masri	MOHE FRG (RM 32,000.00)
Characterization of Wood–polymer Composite (WPC) for Bearing Materials	Assoc. Prof. Dr. Sinin Hamdan	Zainal Abidin Talib Dayang Maryani Awg Hashim Md. Abu Affan Dr. Abu Saleh Ahmed	MOHE FRG (RM 24,000.00)
Solid State Carbon Sequestration by Utilization of Agro-wastes to Produce Value-added Products	Dr. Lim Soh Fong	Assoc. Prof. Ir. Dr. Andrew Ragai Henry Rigit Dr. Hj. Mohammad Omar Abdullah	MOHE FRG (RM 24,000.00)
Human Walking Behaviour Based on Different Layout Design Using Computer Animation	Mr. Shahrol Mohamaddan	Mr. Syed Tarmizi Syed Shazali Mr. Abg Mohd Nizam Abg Kamaruddin	MOHE FRG (RM 24,000.00)
Theoretical Development of a Hybrid Fuzzy-Multipleobjective Evolutionary Based Risk Assessment and Decision Making Paradigm for River Transportation	Mr. Ron Aldrino Chan @ Ron Buking	Mr. Tay Kai Meng Prof. Dr. Wan Hashim Wan Ibrahim	MOHE FRG (RM 24,000.00)

On-going Projects

Title	Leader	Co-researchers	Grant
Time Dependent Deflection and Debonding Behavior of Reinforced Concrete Beam Strengthened with FRP Sheets	Assoc. Prof. Dr. Ehsan Ahmed	Assoc. Prof. Dr. Mohammad Ibrahim Safawi Mohd. Zain Mdm. Azida Rashidi Mr. Habibur Rahman Sobuz	MOHE FRG (RM 91,200.00)
On the Use of Fuzzy Inference Techniques in Assessment and Decision Problems: From Theoretical Development to Applications	Mr. Tay Kai Meng	Assoc. Prof. Dr. Teh Chee Siong Ir. David Bong Boon Liang	MOHE FRG (RM 78,000.00)
Improvement on Particle Image Velocimetry Analysis on Simple Soil – Structure Interaction	Dr. Siti Noor Linda Bt. Taib	Dr. Prabir K. Kolay Lau See Hung	MOHE FRG (RM 34,400.00)
Design and Development of a Mechatronic Harvester for Harvesting Pepper in Typical Terrains	Ir. Dr. Mohammad Shahril Osman	Mr. Shahrol Mohammaddan Mr. Noor Hisyam Noor Mohamed Mr. Aidil Azli Alias Ms Siti Nor Ain Musa Ms Shafrida Sahrani Mr. Abg Mohd Nizam Abg Kamaruddin Ms. Nur Tahirah Razali Mdm. Maimun Huja Husin Ms. Kasumawati Lias	Malaysia Pepper Board (RM 95,000.00)

Completed Projects

Title	Leader	Co-researchers	Grant
Hydrosystem for Integrated Control of Flood and Low Flow for a River Basin in Sarawak	Mr. Charles Bong Hin Joo	Prof. Frederik Josep Putuhena Prof. Salim Said Mdm. Rosmina Ahmad Bustami	MOSTI e-Science (RM 197,302.00)
Development of an Efficient Hybrid Solar Thermoelectric-Adsorption Cooling System	Dr. Mohammad Omar Abdullah	Prof. Dr. Khairuddin Ab. Hamid	MOSTI e-Science (RM 143,000.00)
Dielectric Barrier Discharge (DBD) Plasma Actuator for Fluid Flow Control	Assoc. Prof. Ir. Dr. Andrew Ragai Henry Rigit	I. Dakek K.C. Lai D.B.L. Bong	MOSTI e-Science (RM 100,000.00)
Estimation of Parking Pricing Model to Mitigate Congestion in Congested Business Districts	Mr. Mohamad Raduan bin Kabit	Prof. Dr. Wan Hashim Wan Ibrahim Mr. Zamri Bujang	MOHE FRG (RM 35,500.00)

Consultation Works

Title	Leader	Co-researchers	Client
Mapping of Tidal Energy for Sarawak	Assoc. Prof. Ir. Dr. Andrew Ragai Henry Rigit	-	Sarawak Energy Bhd.
Roadside Interview and Screen Line Survey	Prof. Dr. Wan Hashim Wan Ibrahim	Mr. Larry Silas Mr. Ron Aldrino Mr. Zamri Bujang	Highway Planning Unit and Perunding Atur Sdn. Bhd.

Design and Development of an Electrohydrodynamic (EHD) Micropump with a Flow Simulation Study

A.R.H. Rigit (Leader), D.B.L. Bong, A. Joseph, J. Labadin, M.A. Idris (UNITEN) and K.C. Lai (UTAR)

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Microfluidics technology has been attracting significant interest due to its vast potential to create miniature tools for life sciences such as microelectromechanical systems (MEMS) and drug delivery systems (DDS). One of the most important components of a microfluidics device is a micropump. With the increasing demand, micropumps have been applied to numerous applications in industrial and medical fields in the last decade [1]. Micropumps can be categorized into two groups, one type is the mechanical micropumps and the other is the non-mechanical micropumps [2]. The former, which includes moving parts such as check valves, oscillating membranes or turbines, is mostly used for large-scale applications to provide high flow rates. Non-mechanical micropump, which has no moving parts, can add momentum to the fluid by converting potential energy into the kinetic energy. It has advantages for micro scale applications. The examples for non-mechanical pumps include electrohydrodynamic (EHD) pumps, electro-kinetic (EK) pumps and magneto-hydrodynamic (MHD) pumps. This study will look into the EHD micropumps.

The application of the EHD micropumps ranges from controlling and delivering tiny amounts of fluids to another on a lab-on-a-chip system to provide means of conducting laboratory experiment [3]. The electric field is established between a charged electrode called emitter and a grounded electrode called collector. The friction between the moving ions and the working fluid drags the fluid towards the collector, thus setting the fluid in motion. The micropumps are used to administer small amounts of medication or reagent for disease treatment, and to control micro volume samples of human cells into a micro-channel for cell separation, sensing and identification.

Despite the effort invested in micropumps, there is still a need for a low power, simple and inexpensive micropump to fulfill the demands for lab-on-a-chip devices that require moving fluids of small volume [4]. Influence of the design geometry on micropump characteristics should be investigated in order to provide a large discharge volume and a low backward flow. Work is necessary to optimize the structure of micropump, and to characterize the physical and mechanical properties for micropump [5]. Thus, one of the goals of this study is to utilize 3D fluid models of the discharge to understand the induced EHD force, and to provide an efficient design to yield high liquid flow rate.

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Design and Development of DNA Sequences Based on Multi-objective Particle Swarm Optimization for DNA Computing

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Particle swarm optimization (PSO) is a population based stochastic optimization technique developed by Dr. Eberhart and Dr. Kennedy in 1995 [1], inspired by social behavior of bird flocking or fish schooling. PSO shares many similarities with evolutionary computation techniques such as Genetic Algorithms (GA). The system is initialized with a population of random solutions and searches for optima by updating generations. However, unlike GA, PSO has no evolution operators such as crossover and mutation. In PSO, the potential solutions, called particles, fly through the problem space by following the current optimum particles. Compared to GA, the advantages of PSO are that PSO is easy to implement and there are few parameters to adjust. PSO has been successfully applied in many areas: function optimization, artificial neural network training, fuzzy system control, and other areas where GA can be applied.

The objective of this study is to apply the PSO for optimizing DNA sequences used in DNA computing. Since DNA sequence design often involves a number of conflicting design criteria, firstly, the problem of DNA sequence design is formulated as a multiobjective optimization problem and then the problem is solved based on PSO. In general, the importance of DNA sequence design is not only restricted in DNA computing field, but also in biological DNA microarrays for gene expression analysis [2], DNA chips for gene sequencing by hybridization [3], nanoscale self-assembly system [4] and molecular transport devices [5].

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Theoretical Evaluation of Effect of Opening on Ultimate Load-carrying Capacity of Square Slabs with Fixed Supports

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Reinforced concrete slabs are the most common elements amongst structural elements in the construction of buildings. In these buildings, many pipes and ducts are necessary to accommodate essential services such as electricity, telephone, computer network, water supply, sewerage and air-conditioning. Due to the need for installing these pipes and ducts, slabs of buildings may need to provide openings for them to be interconnected. The effect of opening on load-carrying capacity needs to be assessed and the theoretical development of an analytical model for fixed-supported square slabs with openings using the yield line theory will be carried out in this project. This analytical model can be used to investigate the effect of opening size on the load-carrying capacity of the slabs. Based on the results, design recommendation for slab with opening can be made.

Self Initialization Network Discovery and Localization Protocol for Underwater Acoustic Network

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The last two decades has witnessed significant progress in the area of acoustic underwater communication technology. An increase in the bit rate and reliability of communication systems has allowed a real time point to point link-up between underwater nodes, such as ocean bottom sensors and autonomous underwater vehicles (AUVs). However, recent research now tends to focus more on combining various point to point links within a network structure. Thus, with this technology, the underwater acoustic network is able to meet the demand of applications such as environment data collection, offshore exploration, pollution monitoring, and military surveillance.

The traditional approach for ocean-column or ocean-bottom monitoring is to deploy underwater sensors that record data during the monitoring mission, and then recover the instruments. This traditional method has several disadvantages. Therefore, knowing the limitations of the traditional approach, an ideal solution is required for real time monitoring. More specifically, a connection of various instruments through a wireless link within the underwater network structure, which would be sustainable for long periods of time, is needed. Underwater acoustic networks, in general, can be formed by acoustically connected anchored nodes, autonomous underwater vehicles (AUVs). A surface link serves as a gateway to provide a communication link to an onshore station.

The problem of underwater positioning is increasingly crucial due to the emerging importance of sub-sea activities such as monitoring the marine environment for scientific exploration, commercial exploitation and coastline protection. The nodes, or underwater sensors, can be dropped randomly or placed in a structured manner in order to perform these applications. Problems arise with this implementation when the location of the nodes cannot be defined. At the surface, positioning problems have been resolved by extended use of GPS, which is straightforward and effective. Unfortunately, using GPS in the sub-sea environment is impossible and positioning requires the use of special systems. Those currently in use are based on anchor nodes system, where positions are determined by triangulation using acoustic sources, whose relative locations are known. However, such techniques are quite restrictive. One of the major challenges in the underwater acoustic networks (UANs) area of research is the development of a network discovery protocol that can cope with the management of a dynamic sub-sea network in terms of node position. Hence, node discovery and localization schemes for sensor networks using only one seed node called primary seed node, in a known position is proposed. The information gained during the primary seed node discovery will assist to set the second and third seed node, thus building-up the relative coordinate system. The self initialization involves some remote nodes becoming seed nodes for further discovery cycles. Using the information gained during the initial stage of discovery, four different algorithms for selecting the secondary seed nodes will be proposed. These algorithms namely; (i) the Farthest/Farthest Algorithm, (ii) the Farthest/Nearest Algorithm, (iii) the Nearest/Farthest Algorithm and (iv) the Nearest/Nearest Algorithm. Performances of different number of nodes in random and fixed network topologies will be investigated. The performances results for the proposed node discovery protocol and localization algorithms in this research can be a set of possible approaches to collaborative location discovery.

A Study to Design an Electrohydrodynamics Micropump for Microelectronics Cooling

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An increased in microelectronics power dissipation and reduction of the device size have resulted in increasing of heat fluxes. Heat flux is expected even higher in future electronics device. The electronics device's temperature must be controlled to retain their performance. New heat removal technique is needed to replace current technique, which is using forced air-cooling. Electrohydrodynamics micropump is a new liquid cooling technique under development. It is popular because of its small size, no wearable mechanical part, cause no vibration, easily controllable, and consume less power. The theories of electrohydrodynamics (EHD) developed in 1960's. The first EHD micropump was developed by in 1998 [1]. Darabi [2] developed the ion drag micropump with saw tooth emitter, which greatly improves the ion generation, thus enhancing the electric field. Benetis [3] investigated the microchannel design geometry on the performance of ion-drag micropump. Shoostari [4] developed the numerical model for the interaction between electric field and dielectric fluid. Parisa [5] designed the micropump that uses liquid nitrogen as working liquid; she studied the charge generation in liquid nitrogen for her design.

The emitter and collector are traditionally planted at the bottom of microchannel; the shortcoming of this design is creating non-uniform electric field, which serves as the only propulsion force in EHD micropump. In this case, dragging force would be weaker at the top of microchannel. Darabi and Rhodes [6] simulated the design with emitter and collector planted at the top of microchannel. However, this design made the fabrication process much complicated. Kazemi et al. [7] came out with micropump pump that come with 3D micropillars inside the microchannel. The micropillars idea creates a more uniform electric field; their micropump generated maximum pressure of 2240 Pa at voltage of 900V. This is believed to be the most successful EHD Ion Drag micropump; however the generated pressure is still too low for practical cooling applications that require 5 – 10kPa. Kazemi et al. [7] provided only the electric field simulation result which showed that electric field gradient is uniform at the top of microchannel, and the graph for experimental results. Thus, this project will be investigating the effect of micropillars geometry on the liquid flow and charge generation in working liquid.

Planting micropillars would definitely impose flow resistance, especially microfluidic is concerned. However proper design and arrangement of micropillars are believed to reduce resistance on the liquid flow and improve the micropump performance, by means of reducing the pressure drop. Meanwhile, changing the micropillars geometry would change the electric field strength as well, as it affects the charge generation in liquid [2]. This project will also look into how 3D micropillars design would affect the charge generation in dielectric liquid.

This research will be started with studying the liquid flow in microchannel, using the commercial CFD software (Star CD). The first stage study will ignore the effect of electric field, and concern on reducing the flow resistance. As a

continuation work of Shoostari [4], interaction between changes generations in liquid will be studied, but with 3D micropillars rather than traditional planar emitter design. To study the EHD phenomenon, the outcome from charge generation process has to be incorporated into Navier-Stokes equations as propulsion force. Star CD is not equipped to solve electrical equation; therefore user programming method may have to be employed to resolve the electrical equations for Star CD. Few prototypes will be fabricated and experiment will be conducted to validate the simulation result.

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Parallel Processing of Time-domain Inverse Scattering Imaging Technique for Breast Tumour Detection

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Breast cancer is the leading cause of cancer death among women worldwide. Early detection is an important issue for effective treatments. Breast cancer screening such as conventional X-ray mammography is currently the most effective imaging method for detecting tumours. However, it has some limitations. X-ray mammograms have been shown to miss up to 15% of tumors, as well as give difficulty to image the 25% of women who have dense breast tissue. Many women find mammography uncomfortable or painful, and there are health concerns related to exposure to ionizing radiation. The concerns related to mammography have generated interest in alternative approaches to breast imaging. Thus, microwave has the possibility to identify breast tumors clearly because tumors show much higher contrast with respect to normal breast tissues at microwave frequencies than at the X-ray frequencies and also due to the fact that the malignant tumors contain much more water than the normal breast tissues. Recently, microwave imaging for early breast cancer detection has been reported by several researchers as alternatives to X-ray mammography for the detection of breast cancer.

There are varieties of microwave approaches utilizing frequency-domain inverse scattering, and ultra-wideband radar-based techniques for breast cancer detection. The former approach has the ability to reconstruct quantitative images with the internal permittivity (ε_r) and conductivity (σ) composition of the breast. In this research work, we investigate a technique for breast cancer detection and analysis which combines the advantages of these two approaches. The time domain scattering data contain more information compared to a single-frequency scattering data. Thus, electromagnetic imaging in time domain has the potential of reconstructing electrical parameter profiles more accurate. We propose the Forward-Backward Time-Stepping (FBTS) technique using broadband microwave signals to solve the inverse scattering problem in the time domain. This technique has the potential to reconstruct images that provide useful quantitative information about the shape and the internal composition of the fibroglandular and fat tissue regions. This research investigates the possibilities of using microwaves and microwave tomography to detect changes in electrical properties of various tissues. The work contains both theoretical modeling and construction of such a scanning system for early breast cancer detection.

Parallel computing is applied to FBTS method, which is one of the solution methods of time domain inverse scattering problem to shorten the calculation time. A cluster of 16 Personal Computers (PCs) will be constructed and parallel processing is realized using MPI. A reconstruction of target (e.g. object or breast model) is examined by parallel FBTS algorithm to provide proper reconstructed profiles of target with respect to relative permittivity and conductivity.

Characterization of Wood–polymer Composite (WPC) for Bearing Materials

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Bearing materials should have special characteristics for the successful operation without failure. Some desirable characteristics for the bearing are compatibility with rubbing counterface materials, embedability for dirt particles and wear debris, conformability to enable the bearing to accommodate misalignment, geometrical errors, and deflection in the structure and thermal stability [1]. Wood is arguably the oldest bearing material, in continuous use since the invention of the wheel. Bearings made of lignum vitae bore the rudder shafts of ships in the golden age of sail, and when the steamship rose to power, its propeller shaft spun in the wood bearings [2]. Since the price of the wood is expensive because it takes lignum vitae three to four hundred years to mature only small cross sections of the wood are available. The life of wood bearing is very short such as three months. The impregnated oil in the wood bearing to improve tribological characteristics contaminates sea water; because the wood bearings of small fishing boats operate under water lubricating condition. Because of these demerits of lignum vitae, new bearing materials for water lubrication are required strongly. Wood polymer composites (WPCs) may be one of the most dynamic sectors of today's plastic industry. WPC generally exhibit low moisture absorption and high resistance to decay, insect, and UV ray damage. Over the years wood has been treated with a variety of chemicals to change its physical characteristics. From 1930 to 1960 a number of new wood treatments were introduced: acetylation of the hydroxyl groups, ethylene oxide addition to the hydroxyl groups, and the phenol formaldehyde treatments [3].These benefits of the WPCs as a structural material have been utilized in marine applications, including fender systems used to protect docking structures and vessels during vessel berthing [4-8].

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Solid State Carbon Sequestration by Utilization of Agro-wastes to Produce Value-added Products

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Solid state carbon sequestration is used to reduce carbon footprint and to minimize waste. The carbon sequestration is a sustainable development process which can be used to curb the negative impacts of human activities by reducing the emission of CO2 via locking the carbon in solid form such as in trees, soils, and other value-added solid products (eg. bio-fertilizer, bio-sorbent, etc.). There are numerous agro-wastes being produced in plantation and processing such as skins/peels cores, pits, leaves, brunches and pericarp. Agro-wastes are recognized as having hidden economic values which could be benefited by transforming the agro-wastes into useful products such as bio-fertilizer and bio-sorbent. Thus, in this work, these agro-wastes will be targeted for potential green technology application and sustainable development/practices. The agro-wastes will be physically and chemically characterized using Transition Electron Microscope (TEM), Scanning Electron Microscope (SEM), Electron Dispersion X-ray (EDX), Elemental Analysis (EA), Total Organic Carbon (TOC), and etc. Then, the selected agro-wastes will be identified for the development of solid state carbon locking mechanism (carbon sequestration) to produce value-added solid products mainly bio-fertilizer and bio-sorbent. Lastly, the products will be characterized and studied for its application. Carbon calculation will be carried out for the whole carbon sequestration process. The main objective of the proposed work is to explore and study the utilization of agricultural wastes to produce value added products (bio-fertilizer and bio-sorbent) by solid state carbon sequestration method. The outcomes of this study will be an alternative method to conserve the natural environment and resources mainly in the ecology system by the reduction of carbon footprint and the minimization of agro-wastes. The utilization of the value-added products from the agro-wastes will provides rural economic development by increases profitability for the farmer.

Human Walking Behaviour Based on Different Layout Design Using Computer Animation

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Human has an ability to decide their own movement or walking without relying on other people. However, different types of human will have different types of walking behaviour for example, an adult, children, elderly and disabled people. The walking behaviour is referred to how people performed their walking related to the time taken for moving from one place to another, deciding the walking direction, avoiding collision from each other and others behaviours that can arise during the walking period. There are a lot of factors that can affect the human behaviour towards walking and the walking behaviours become important especially at the crowded area.

The objective of this research is to study the human walking behaviour for elderly and disabled people. This study is different with other studies because we are focusing on how the different layout design of facilities can influence the human walking behaviour. This study starts with observing the human walking behaviour in crowded area such as bus station, shopping mall and walking pedestrian walkway. Observation process will be taken into two periods of time which is the peak-time and off-peak time period. This is to compare the human walking behaviour when numbers of human are low or high in one period of time. Based on the observation data, mathematical model and prediction model of the human walking behaviour will be developed.

The model is then applied to develop the human walking behaviour algorithm using the computer animation software. In the software, the humans will be interpreted as the 3D object similar to autonomous actor in virtual world where it can perform the walking based on different categories such as elderly and disabled people. The simulation also can predict human walking or movement when different designs are applied. The study is expected to come out with a simulator where it can be used to show suitable layout design for human and to predict human movement during riot situation such as fired hazards, earthquakes, accidents and other emergencies.

Theoretical Development of a Hybrid Fuzzy-Multipleobjective Evolutionary Based Risk Assessment and Decision Making Paradigm for River Transportation

Ron Aldrino Chan @ Ron Buking, Tay Kai Meng and Wan Hashim Wan Ibrahim

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In risk assessment and decision making problems, recent advances focus on the use of soft computing techniques to assess risk and to draw conclusion(s) [1]. Examples include the use of fuzzy systems to evaluate the risk [2-3], the use of genetic algorithm for risk-based remediation design [4], and the use of a genetic-fuzzy system to assess the potential risk in supply change management [5]. Fuzzy systems provide a good representation of uncertainty in quantifying risk assessment [6]. Multiple-objective evolutionary based risk assessment models can be a solution to study the effect of multiple conflicting objectives that govern organization, systems and problem domains. The hybrid of fuzzy system and multiple-objective evolutionary in risk assessment and decision making is very new.

The river transport system in Sarawak state has a great significance to a large section of the population living in the interior and along the coast. It transports passengers and goods to various parts of the State. An official report from Sarawak Government reports that there are up to 500 registered boats and vessels ply on the rivers daily [6]. Thus, management and control of river tranports are crucial in Sarawak. Despite of the popularity of river transport in Sarawak, a search in literature reveals that there is no investigations on the safety and risk assessment on river transport infrastructure facilities has been reported.

The aims of this research are: (1) to develop a novel hybrid of fuzzy system and multiple-objective evolutionary paradigm for risk assessment and decision making, and (2) to demonstrate and evaluate the use of the proposed paradigm in river transportation. Information from several related government institution, i.e., Sarawak River Board (SRB), Marine Department and JKR (Jabatan Kerja Raya) will be gathered for development purpose.

From this research, a novel risk assessment and decision making paradigm is expected to be developed, which can be a solution for various risk assessment and decision making problems. The developed paradigm is expected to allow uncertainty and multiple conflicting objectives to be considered. A tool is to support the operation of terminal authorities in the river transport industry in Sarawak will be developed.

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Time Dependent Deflection and Debonding Behavior of Reinforced Concrete Beam Strengthened with FRP Sheets

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This research project investigates the long-term behavior of reinforced concrete beam strengthened with fiber reinforced polymer sheet. Recent studies have shown that external bonding of Fiber Reinforced Polymer (FRP) sheets is an effective method to strengthen and retrofit deteriorated or damage reinforced concrete or prestressed concrete structures. However, the long-term serviceability of such FRP-strengthened beams is still a concern due to lack of long-term performance data. Another problem which limits the full utilization of the material strength is the premature failure due to debonding of FRP sheets.

In this research project, both the theoretical and experimental study will be carried out to investigate the debonding and the time-dependent performances of FRP sheet strengthened Reinforced Concrete (RC) beam. The main focus of this research is to gain proper understanding on the debonding and long-term behaviour of the FRP sheet strengthened concrete structures and also to develop reliable analytical and numerical modelling technique in agreement with the experimental results. The availability of the component materials especially the fiber sheet and the suitability of such strengthening technique with respect to the local context will also be investigated.

Progress:

Serviceability of concrete can be defined as satisfactory performance under service load conditions which in turn can be described in terms of two basic parameters namely cracking and deflection. Deflections constitute one of the important serviceability criteria in the design of concrete structures [1]. To keep the deflection of reinforced concrete (RC) members within allowable limits, in addition to appropriate design and construction procedures, the use of appropriate materials like short fiber reinforcements to provide higher beam stiffness and better crack control, have been recommended by ACI committee 435 (1995) [2].

Creep and shrinkage deformation of reinforced concrete structures is often responsible for excessive deflection at service loads. To study the effect of creep and shrinkage on the FRP strengthened beam, this project work is divided into three main stages. In the first stage, a vast literature review was carried out to get an understanding of the problem and also to identify and develop suitable analytical solution for such strengthening problem.

From the literature review, it was identified that most of the work addressed the flexural performance of such strengthened beam [3-7]. As expected, all the research showed an increase in the flexural strength and stiffness for the strengthened beams. However, debonding of FRP sheet was one of the major concerns in some studies [8-10]. To avoid the premature failure of the beam due to debonding, U shape end anchorage, fiber/strips orientation at different angle, wrapping FRP around the whole cross section of beam, FRP layer and width variation have been adopted in some studies[11-14]. It was identified that the use of U-strips offered a slight improvement to the load carrying capacity as compared to the control beam that failed prematurely by concrete separation. On the other hand, a U-shape strip warped around the FRP soffit plate was found to be more effective than the U-strip end anchorage. From the experimental investigation, it was also observed that the attachment of FRP with different layer and width variation on the soffit of the beam has substantially increased the ultimate load carrying capacity of the strengthened beam. The FRP strengthening was also effective in delaying the formation of first crack. Based on this, the suitable

length and spacing required for stirrup to avoid premature failure of the beam has been adopted in this study.

Based on the ACI recommended technique [2], an analytical method was developed and tested by applying to some experimental beams [15]. It was identified that the accuracy of the analytical methods depends on certain factors. For the cracked beam section, beside the creep coefficient and ultimate shrinkage strain, another factor which can influence the theoretical result is the tension stiffening, noting that concrete has the ability to carry tensile stress between cracks in the tension zone due to the bond between the steel and concrete. The tensile concrete area is assumed to contribute to the beam stiffness after cracking and depends on the magnitude of the maximum applied moment, the area of tensile reinforcement and FRP reinforcement ratio, the amount of concrete below the neutral axis, the tensile strength of concrete (the cracking moment) and the duration of sustained load. In this study a refined tension stiffening model based on available model in literature are proposed to get more accuracy in the theoretical results.

In the second stage to get sufficient data on long-term behavior of FRP strengthened beam, twelve (12) beams have been casted in the laboratory. For all beams, the mix proportion was set at 1:1.65:2.45 by weight of cement, sand and crushed stones with corresponding water/cement ratio 0.45. Among these, three are control (not bonded with FRP laminates) beams, three beams are bonded with one layer of FRP, three beams are bonded with two layer of FRP and rests of the beams are bonded with three layers of FRP sheet. First eight beams (cracked and uncracked section) will be used to investigate the long-term deflection and cracking performance whilst the remaining four beams will be used for flexural testing. Table 1 shows the experimental specimen details to evaluate long-term deflection and flexural performance of beams. Fig. 1 shows the cross-sectional and longitudinal details of the test beams.

Table 1: Test Program for Long-term Deflection and Flexural Performance

CB (Not attach FRP)	CB1 (1 layer FRP attachment)	CB2 (2 layer FRP attachment)	CB3 (3 layer FRP attachment)	Remarks
CB-U	CB-1LU	CB-2LU	CB-3LU	Uncracked section
CB-C	CB-1LC	CB-2LC	CB-3LC	Cracked section
CB-F1	CB-1LF	CB-2LF	CB-3LF	Flexural test

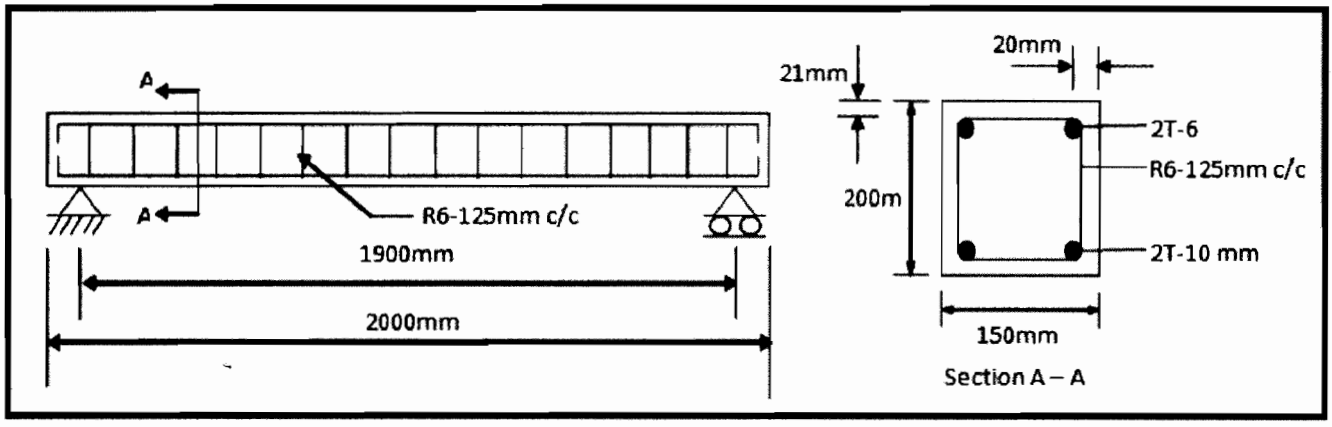

Figure 1: Longitudinal and Cross-Section Details of the Experimental Beams

Few beams have been tested in the laboratory for predicting long-term deflection and flexural performance. Two different setups were made for the flexural and long-term deflection performance tests. In both cases the beams were simply supported on a span of 1900 mm. Fig. 2 and Fig. 3 show the instrumentation details for flexural and long-term deflection performance tests.

Figure 2: Loading and Instrumentation of Typical Test Beam for Flexural Test

Figure 3: Loading and Instrumentation of Typical Test Beam for Long-Term Deflection Test

From the experimental investigations of flexural test, the first cracking load and the ultimate capacity of the test beams were noted as 13.5 kN and 46.5 kN respectively. Fig.4 shows the crack pattern of the control beam under loading and Fig.5 shows the typical load-deflection behavior of the beam in flexural test.

Figure 4: Crack Pattern of the Control Beam under Loading

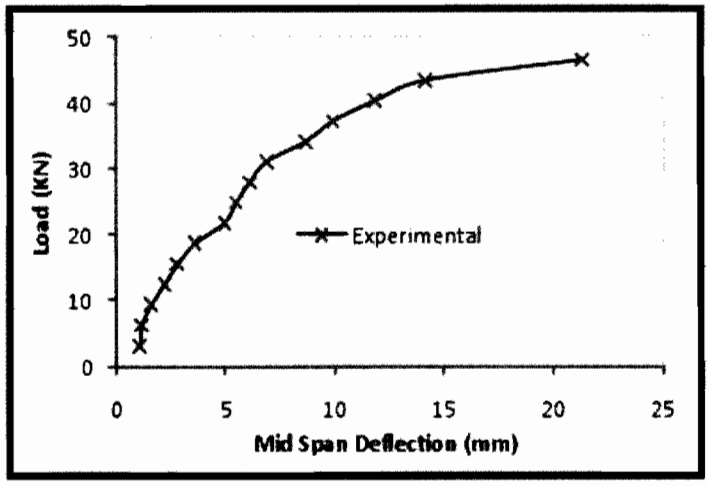

Figure 5: Typical Load-Deflection Behavior of the Beam

Long-term deflection results were collected up to 150 days after the sustained loading were imposed on the two experimental beams. The experimental and theoretical results of long-term deflections for the uncracked and crack beams are shown in Fig.6 and Fig. 7 respectively. It was observed that for the control beam, the deflection after five months period was 10% more in cracked section as compared to that of uncracked section.

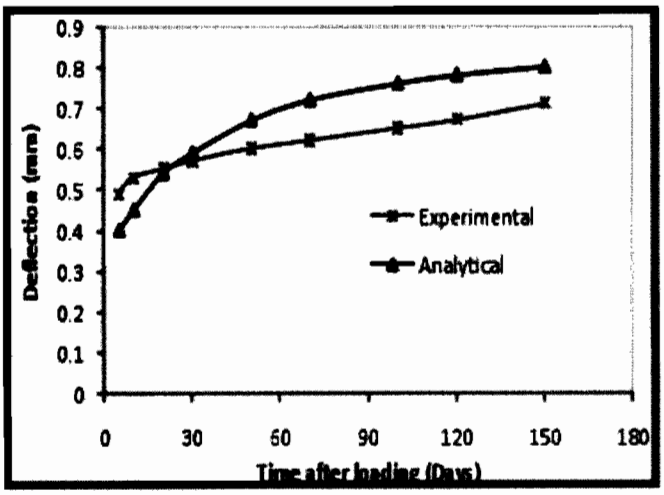

Figure 6: Long-Term Deflection of Uncracked Beam (Loading = 4.32kN/m)

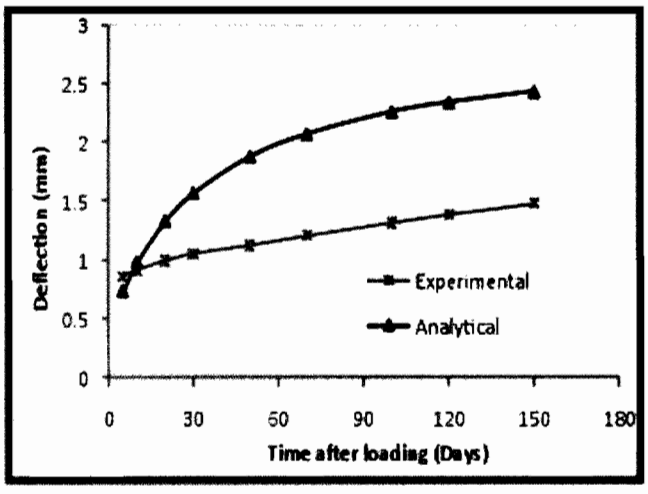

Figure 7: Long-Term Deflection of Cracked Beam (Loading = 8.58 kN/M)

In the final stage, commercially available FE software LUSAS will be used to develop a numerical model for predicting long-term performance of the FRP sheets strengthened reinforced concrete beams. The numerical model will be validated using experimental results.

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On the Use of Fuzzy Inference Techniques in Assessment and Decision Problems: From Theoretical Development to Applications

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The Fuzzy Inference System (FIS) is a popular paradigm for undertaking assessment, measurement, selection and decision problems. In an FIS-based assessment/measurement model, attributes are assumed to be the inputs of the FIS, and the measuring index as the output of the FIS. The relationship between the attribute(s) and the measuring index is described by a set of fuzzy If-Then rules. The use of the FIS model in the assessment/measurement domain appears to be popular in the literature. Examples include an FIS-based Risk Priority Number (RPN) [1] model for Failure Mode and Effect Analysis (FMEA), an FIS-based Occurrence model [2] for FMEA, an FIS-based education assessment model [3], an FIS-based groundwater vulnerability assessment [4] model, and various FIS-based risk assessment models [5-7]. There are several reasons why the FIS model, instead of conventional assessment models, is preferred. These include (a) the FIS model allows the modeling of the nonlinear relationship between the measure index and the attributes [1,4]; (b) the FIS model is robust against uncertainty and vagueness [5-8]; (c) the scale for attribute(s) can be qualitative, instead of quantitative, scales [1,3,5].

The aim of this research is to investigate on the theoretical properties associated to an FIS-based assessment/measurement model, i.e, monotonicity and output resolution. These properties are mathematically defined and formulated. Mathematical conditions of an FIS to fulfill these theoretical properties are studied via a series of mathematical derivation. The applicability of these mathematical conditions in two FIS-based assessment/measurement models, i.e., a proposed FIS-based RPN and an FIS-based Occurrence model for FMEA, are further demonstrated and evaluated with data/information collected from several multi-national corporations, i.e, *Intel Technology, Motorola Technology and Multi-resource,*

Progress:

In this research, an FIS is viewed as mathematical function, $y=f(\bar{x})$, where $\bar{x}=(x_1,x_2,...,x_n)$. If for all x_i^a and x_i^b such that $x_i^a < x_i^b$, then for a function f to be monotonically increasing or decreasing, the condition $f(x_1,x_2,...x_i^1,...,x_n) \le f(x_1,x_2,...x_i^2,...,x_n)$ or $f(x_1,x_2,...x_i^1,...,x_n) \ge f(x_1,x_2,...x_i^2,...,x_n)$ must be fulfilled, respectively. Inspired by the *sub-additive* principle of *a length function* [9], it is possible extend the monotone property to another useful property. This research further proposes a novel theoretical property for FIS based assessment model, i.e., the output resolution property. The output resolution property for monotonically increasing or decreasing FIS, is defined as in Equations (1) or (2) respectively.

$$f(x_1,x_2,...\,x_i,...,\,x_n) + \alpha \le f(x_1,x_2,...\,x_i+\varepsilon,...,\,x_n)\text{ , where } \alpha > 0 \qquad (1)$$

$$f(x_1,x_2,...\,x_i,...,\,x_n) + \alpha \ge f(x_1,x_2,...\,x_i+\varepsilon,...,\,x_n)\text{ , where } \alpha > 0 \qquad (2)$$

These theoretical properties are important to ensure the effectiveness and validity of an FIS assessment model, as further explained in [2, 10]. In this research, mathematical conditions of an FIS to fulfill monotonicity (increasing or decreasing) property is investigated using the *partial differentiation* and the *quotient rule,* with Equations (3) or (4), respectively. The output resolution

property for monotonically increasing or decreasing FIS, is also investigated with Equations (5) or (6), respectively.

$$f'(x_i) \geq 0 \tag{3}$$

$$f'(x_i) \leq 0 \tag{4}$$

$$f'(x_i) \geq \alpha, \textbf{ where } \alpha > 0, \tag{5}$$

$$f'(x_i) \geq \alpha, \textbf{ where } \alpha < 0, \tag{6}$$

From our investigation on the monotonicity property, a set of *sufficient conditions* is derived. These *sufficient conditions* are further developed into a novel method to construct an FIS based assessment model. A *rule-refinement* method is proposed to improve the output resolution property. We explain the failure of an FIS to fulfill output resolution property with *true score theory,* which states that every psychological measurement is subject to a measurement error [11].

Our team aliased with several multi-national corporations for experimental purpose. Data and information is collected from these corporations for modeling, and positive result is gained. The motivations of our work are also highlighted by several very recent and influential journal articles [12-14]. Part of our research approaches and theoretical foundations are harmony with a recent publication [12]. From this research, quite a number of journal articles, book chapters, and proceeding papers have been produced. Several are accepted and published.

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Improvement on Particle Image Velocimetry Analysis on Simple Soil – Structure Interaction

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Particle Image Velocimetry (PIV) has been widely used in fluids analysis. This project is to expand the ability of the method into analyzing soil displacements in geotechnical engineering. With this method, usage of physical markers that affect most geotechnical testing measurements will be avoided. Hence, increases measurement accuracy. Several pioneering works have been published; i.e. [1-2]; on using this technique in geotechnical testing especially centrifuge testing. This project, on the other hand, is to apply the method on general laboratory testing and focus on soil-foundation interaction; with future aim to apply the technique on observing displacements of difficult soil. In addition, improvement on the available PIV program shall be performed to suit the geotechnical testing environment. This involved substantial computing works using MatLab. A method to validate measurement on PIV is also designed in this project and subsequently, soil-foundation testing is performed under variation of loading conditions (i.e. different size and shape of foundation plates, size of loading fixtures and the eccentric placement of the loading fixture). Fig. 1 shows the experimental set up designed for this research.

Figure 1: The Experimental Set Up

Progress:

Camera Calibration and Measurement Validation:

Camera calibration procedure and validation testing have been performed successfully in order to ensure reliability of the measurements attained in the soil foundation tests.

Camera calibration was carried out by utilizing a high resolution camera (CANON G9) in capturing the images for the image processing. The calibration was carried out using a camera calibration toolbox specially developed to be run in the platform of MATLAB. Images were captured and then loaded into the camera calibration toolbox for further analysis to determine the parameters of skew and distortion that could occur in an image captured using the camera (CANON G9) with resolution 12.1 Megapixels.

In the validation test, a point in the object-coordinate system is correlated to the corresponding point in the image-place coordinate system. This was achieved by linearly scaling the coordinates between the object and image spaced coordinate. The validation test involved in capturing a grid of target dots with a known distance of 30 mm on a dark background which was known as the world-coordinate. This validation board was then displaced by a known value which was measured using the linear variable displacement transducers (LVDTs). Fig. 2 shows the validation set up. Images of the displaced model box were also captured using a camera which was positioned directly perpendicular to the plane of the target and then were stored in the computer for further analysis using the MatPIV toolbox [3]. The result of the MatPIV study was then compared with the data measured using the transducers.

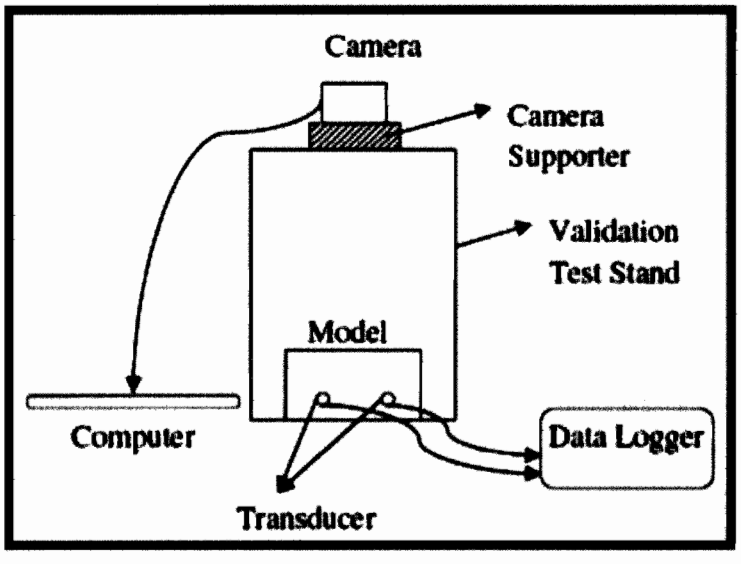


Figure 2: Camera Validation Set Up

A set of 70 data for the validation test was carried out by adapting several error parameters to the analysed images. A statistical data analysis was also carried out to study on the distribution of the data. From the validation test, MatPIV analysis showed an average of 1.6 % error with a p-value of 0.862 for a known displaced measurement. This statistical analysis showed that MatPIV toolbox is suitable to be used in measuring the soil displacement with tolerable percentage of error.

Test Programmes and Sample Results:

A total of 54 test programmes were performed and are listed in Table 1. These tests involved capturing images of soil-foundation behavior under effects of different size and shape of foundation plates, size of loading fixtures and eccentricity placements of the loading fixture.

Table 1: Soil Foundation Test Programmes

No.	Test Description			
	Plate Shape	**Plate Size**	**Fixture Size**	**Loading Point**
Test 1,2,3	Square	40×40mm2	10 mm	Centre, Corner, Side
Test 4,5,6	Square	40×40mm2	5 mm	Centre, Corner, Side
Test 7,8,9	Rectangular	40×45 mm2	5 mm	Centre, Corner, Side
Test 10,11,12	Rectangular	40×60 mm2	5 mm	Centre, Corner, Side
Test 13,14,15	Rectangular	40×80 mm2	5 mm	Centre, Corner, Side
Test 16,17,18	Rectangular	40×45 mm2	10 mm	Centre, Corner, Side
Test 19,20,21	Rectangular	40×60 mm2	10 mm	Centre, Corner, Side
Test 22,23,24	Rectangular	40×80 mm2	10 mm	Centre, Corner, Side
Test 25,26,27	Square	30×30mm2	10 mm	Centre, Corner, Side
Test 28,29,30	Square	55×55mm2	10 mm	Centre, Corner, Side
Test 31,32,33	Square	30×30mm2	5 mm	Centre, Corner, Side
Test 34,35,36	Square	55×55mm2	5 mm	Centre, Corner, Side
Test 37,38,39	Circular	30 mm	5 mm	Centre, Side
Test 40,41,42	Circular	40 mm	5 mm	Centre, Side
Test 43,44,45	Circular	50 mm	5 mm	Centre, Side
Test 46,47,48	Circular	30 mm	10 mm	Centre, Side
Test 49,50,51	Circular	40 mm	10 mm	Centre, Side
Test 52,53,54	Circular	50 mm	10 mm	Centre, Side

In the tests, a soil-foundation set up was loaded until failure in the unconfined compression machine. Images were recorded at different time intervals and were further analysed via MatPIV [3].

In experimenting the effect of different loading fixture size, two sizes were selected which are the 5mm and 10mm diameter fixtures. In this analysis, images of the displaced soil sample were captured to observe the profile of the soil displacement under the effects of different surface area of the loading fixtures. Fig. 3 shows the displacement caused by different size of loading fixtures applied to a square foundation plate of 40 × 40 mm^2 within a measured time, t.

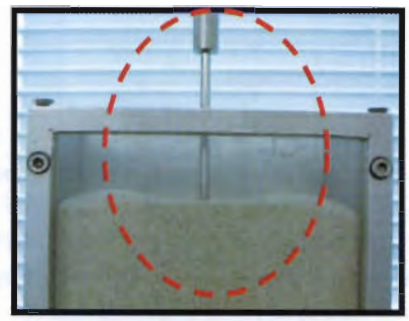
It was shown in Fig. 3 that for soil displacement ranging from 0 – 0.3 mm the measured stresses on the soil surface does not differ much in between the two types of loading fixtures applied. However, when the soil displacement increased to 0.3 mm and onwards it was shown that higher amount of stress was required for a 10 mm loading fixture to perform the same magnitude of displacement.

The mode of displacement of the soil particles prior and after the structural loading is shown in Fig. 4 (a) for 5mm loading fixture. The arrows in the figures illustrated the movement of the soil particles only. In order to measure the magnitude of displacement, test was run on the platform of MatLAB as shown in Fig. 4 (b). In the initial stage when t = t1, the maximum magnitude of displacement measured was 0.31 mm. When the structured loading increased to t = t2, the soil was stressed further thus causing the maximum soil displacement to increase to 2.50 mm.

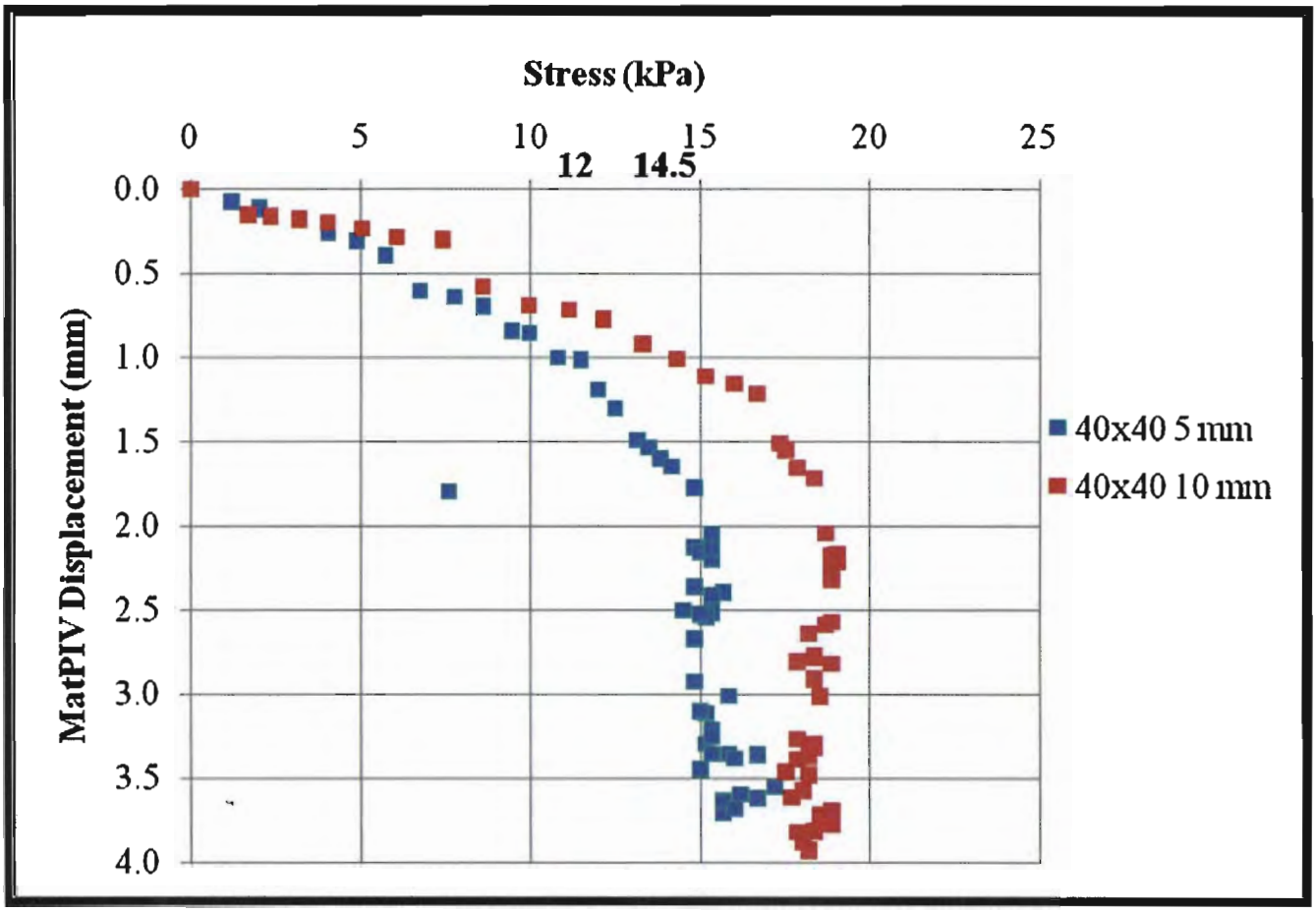
Fig. 4 (c) shows the shear strain and the normal strain of the soil sample under centered loading for time t = t1 and t = t2. In the shear strain test, study was carried out by measuring the difference of horizontal movement of the soil particle for t = t1 and t = t2. Furthermore, it was

assumed that the sign convention for the shear strain analysis in soil was positive when it moved to the right and negative when the soil particles moved to the left. On the other hand, in the normal strain analysis, study was carried out by measuring the difference of vertical movement of the soil particle for t = t1 and t = t2. It was assumed that the sign convention for the normal strain analysis in soil was positive when it protruded upward and negative when it was pressed downward. Fig. 4 (c) shows that when the structural loading increased, the shear strain and the normal strain increased from ± 0.01 % to ± 0.1 % in the direction as discussed.

(a) 10 mm Loading Fixture

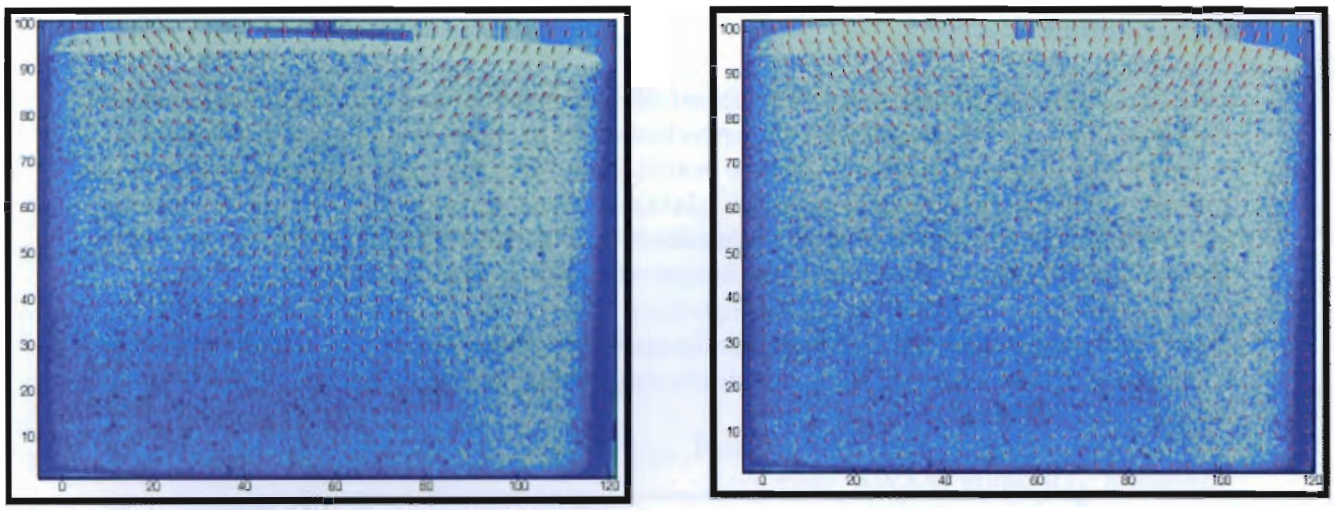


(b) 5 mm Loading Fixture

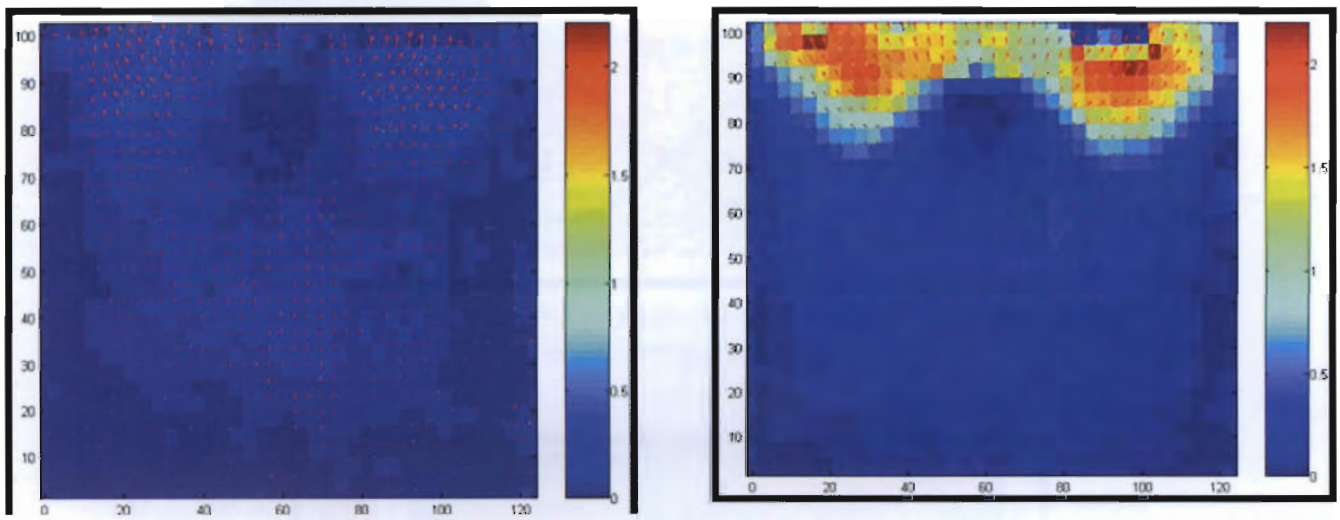


(c) Graph of Displacement (mm) Versus Stress (kPa)

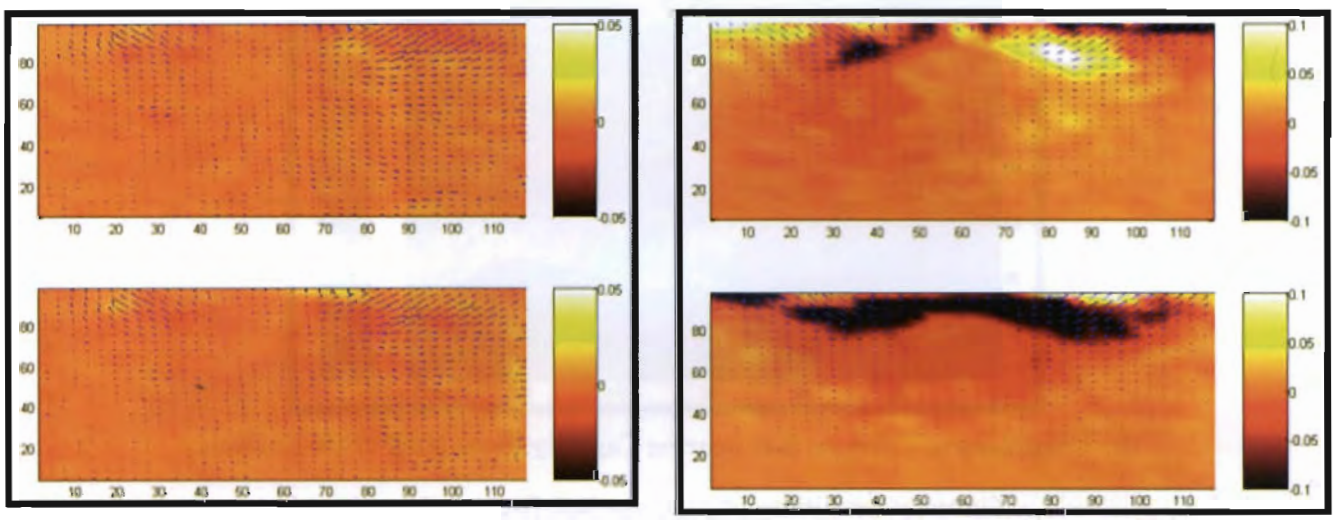
Figure 3: Soil Displacement Under Different Loading Fixtures of (a)10 mm, (b) 5 mm and (c) Graph of Displacement (mm) Versus Stress (kPa) for Plate 40×40 mm^2



(a) Mode of Displacement



(b) Magnitude of Displacement (mm)



(c) Shear and Normal Strain Analysis

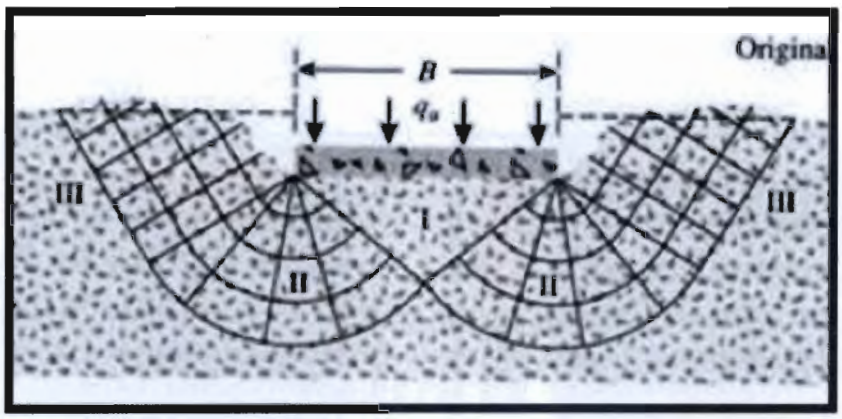
Initial Test, t_1 Final Test, t_2

Figure 4: MatPIV [3] Analysis for Plate Size 40 × 40 mm^2 Under the Effect of 5 mm Diameter Loading Fixture

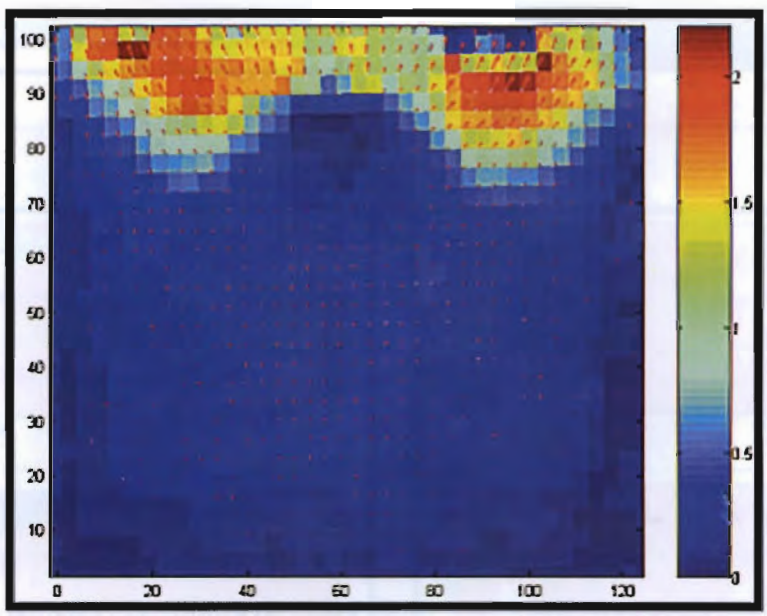
Conclusions:

The test programmes were successfully performed and results are currently being analysed by the authors. Improvements have been made on the method to calibrate the camera and to validate results from MatPIV [3]. The size of loading fixtures, size and shape of foundation plates and eccentricity placements of loading do affect bearing capacity of soils under study and these findings correlate well with the classical theories of shallow foundation analysis as shown in Fig. 5.

For further works, a real time analysis of the method is suggested and shall be included in the teaching of undergraduate and postgraduate geotechnical laboratory courses in UNIMAS.



(a) Conditions of Ultimate Soil-Bearing Capacity in General Geotechnical Engineering Textbooks [4]



(b) Conditions of Ultimate Soil-Bearing Capacity From MatPIV [3] Analysis

Figure 5: Conditions of Ultimate Soil-Bearing Capacity

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Design and Development of a Mechatronic Harvester for Harvesting Pepper in Typical Terrains

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Spices such as pepper are usually found in Sarawak, Malaysia. Pepper vines are usually found on a typical hilly terrain as they grow well in such conditions. This makes the pepper harvesting to be laborious, hazardous and time consuming. This project aims to design and develop a mechanized pepper harvester that will be used at pepper plantation. The said design will employ robot technology as the project is to mechanise the process. The design will consist of a chassis that forms as the body of the robot. Fig. 1 shows the inner part of the chassis. The chassis also housed the manipulator arm that will be designed to cope with the four metre length as this is the height of an average pepper vines. The manipulator will be connected to end-effectors that will be specially designed for this purpose. The design was firstly detailed out using Axiomatic Design concepts to ensure the proper functions and requirements were in place. In addition, information regarding the problems associated with harvesting the pepper was conducted. The complexity in designing such a harvester lies with the manner of the plant. Pepper berries grow all over the plant, which makes the engineering challenge in designing the harvesting method.

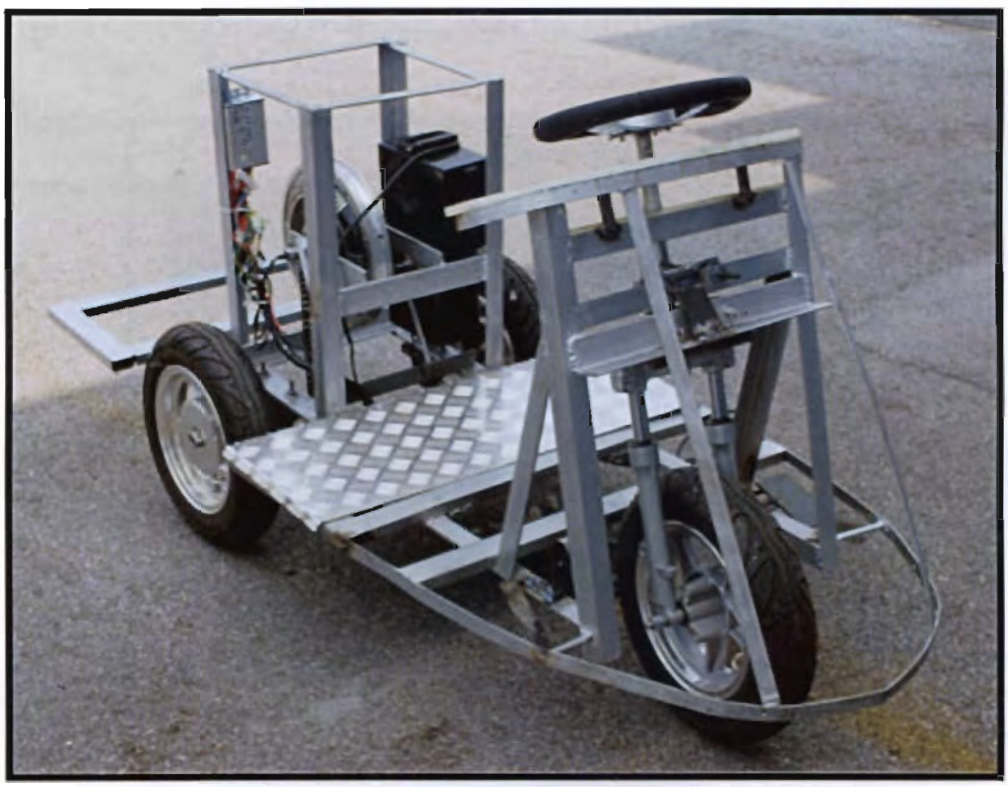

Figure 1: Chassis of the Pepper Harvester

Hydrosystem for Integrated Control of Flood and Low Flow for a River Basin in Sarawak

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Sarawak River Basin is generally quoted as 2375 km2 in size and only 6% of the area is developed. Nevertheless, the catchment size is enormous and the river networks covers huge areas including some hard to reach topography (see Fig. 1). Due to this, Sarawak River Basin was chosen as research area and following are achievements drawn this current study:

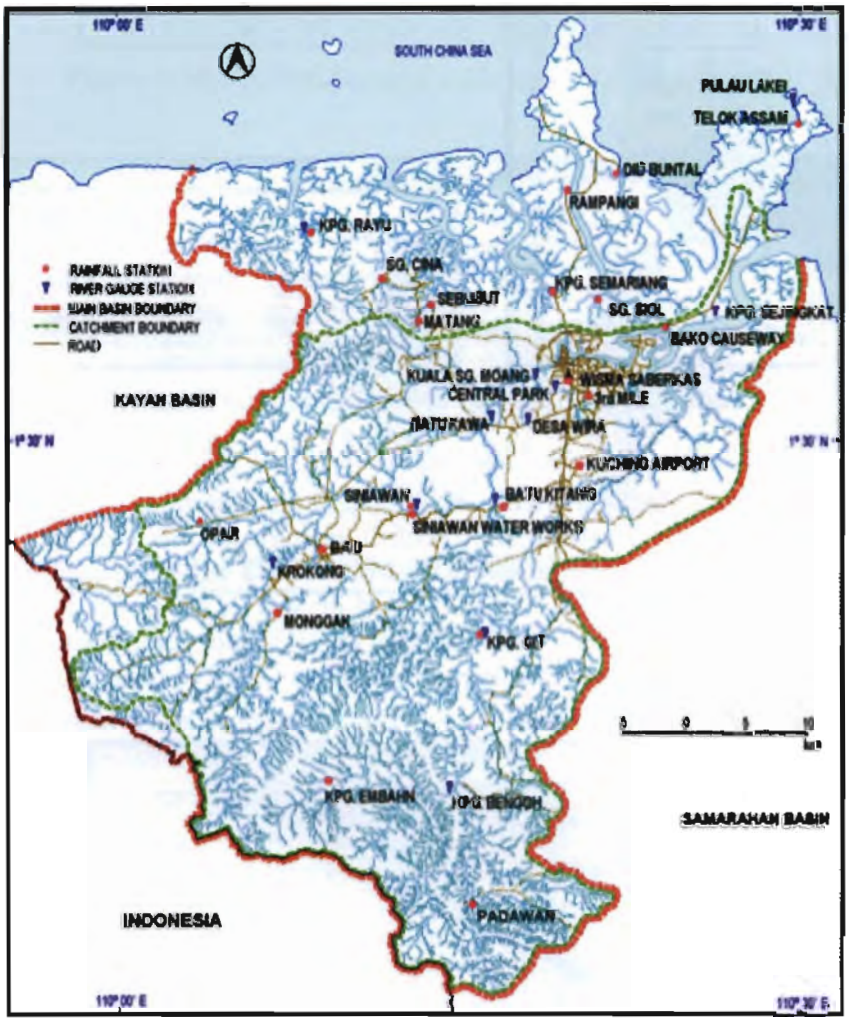


Figure 1: Sarawak River Basin [1]

By using regionalization technique, Sarawak was sub-divided into five flood frequency region (FFR) and two mean annual flood regions (MAFR). Sarawak River Basin is located in FFR-1 and MAFR-2. With that, engineers could come out with flood estimation for a certain site within the Sarawak River catchment, by multiplying the regional dimensionless flood frequency curve (Fig. 2) with the regional mean annual flood equation representing the site (Fig. 3).

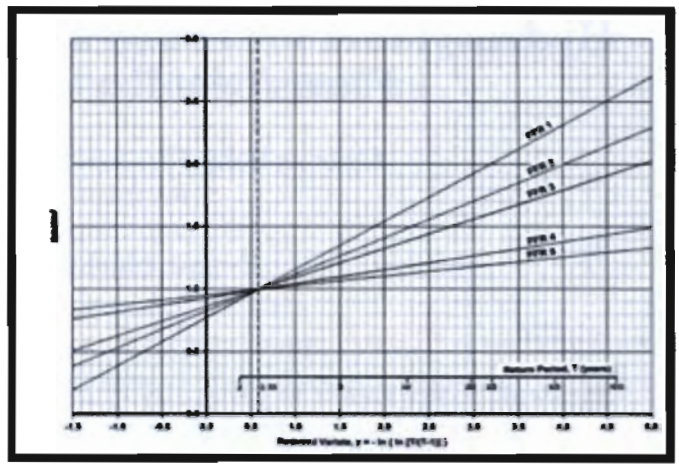
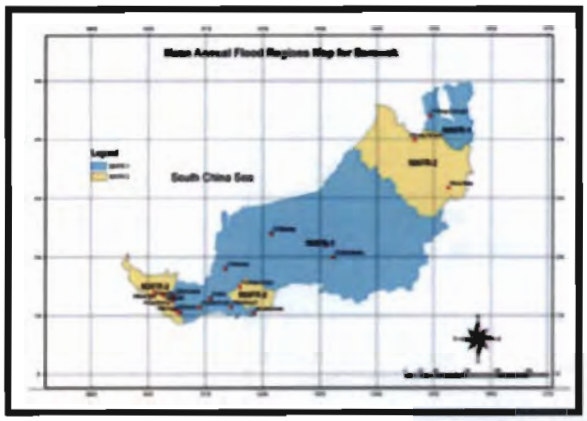


Figure 2: Flood Frequency Region and Regional Dimensionless Curve



Region	MAF Equation	Catchment Characteristics Constant c	A	b	Multiple Coefficient of Correlation Squared
MAFR 1	MAFR 1= $10^{0.7889}$ $A^{0.9944}$ $R^{-2.1943}$	5.4438	0.9944	-2.1943	0.99
MAFR 2	MAFR 2= $10^{1.9554}$ $A^{0.6136}$ $R^{-1.5927}$	92.6323	0.6136	-1.5927	0.95

Note: A in km² and R in meter

Figure 3: Mean Annual Flood Regions and Equations

The existing 23 rainfall stations within Sarawak River Basin were subjected to pattern and frequency analyses to better understand the rainfall occurrence and characteristics in the basin. From the rainfall pattern, it could be concluded that prevailing wind during the northeast monsoon season which commences in early November till end of March is mostly influencing the rainfall distribution in coastal areas of the basin while inlands is less under its influenced. Rainfall frequency analysis was performed in reduced variate curves based on Gumbel Distribution (Fig. 4).

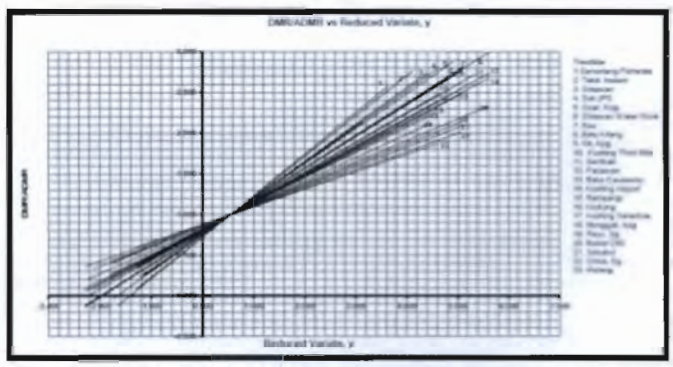


Figure 4: Trendlines of Frequency Analysis in Reduced Variate Based on Gumbel Distribution

InfoWorks RS modeling software was applied to model Sarawak River Basin system. 7 models were developed to provide a platform for understanding of river behaviors, its processes during high flow events and possible engineering solutions. Such computer models were proven to be a powerful tool and assisted decision making. Fig. 5 shows model simulation of the January 2004 flood. The

computer model helps in identifying the priority areas most likely need emergency notification, critical time for evacuation and most effective route for relief (see Fig. 6) and this information support the planning and development of Integrated River Flood Management framework for Sarawak River Basin.

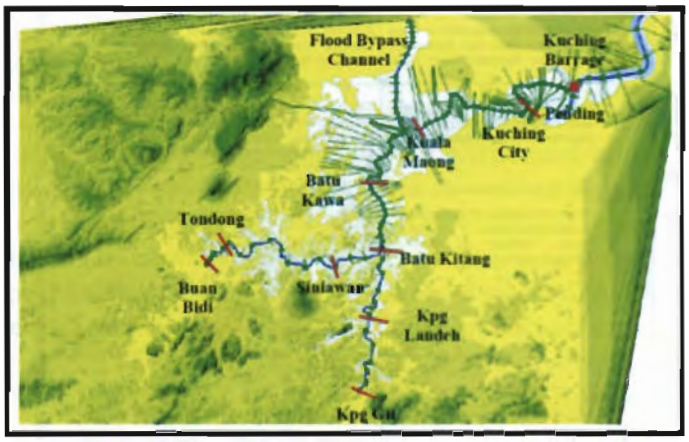


Figure 5: Model Simulation of January 2004 Flood Event

January 2004 Flood Event Simulation Results

Flood Levels from Bankfull

	1st 0.5 m			2nd 0.5 m			3rd 0.5 m			4th 0.5 m			Remarks
	L^	t	L/t*	L^	t	L/t*	L^	t	L/t*	L^	t	L/t*	
Lower Sungai Sarawak													
Pending	1.816	0.40	4.541	1.830	0.45	4.068							Rank 2
Kuala Maong	2.005	0.40	5.012	2.032	0.35	5.806	2.069	0.40	5.174	2.091	0.50	4.183	Rank 1
Upper Sungai Sarawak													
Batu Kawa	4.636	2.40	1.932	4.689	4.05	1.155	4.689	6.30	0.744	4.785	3.10	1.542	
Sungai Sarawak Kanan													
Tondong	1.929	7.00	0.276	1.903	4.20	0.451							
Siniawan	2.186	1.20	1.822	2.212	1.55	1.427	2.240	3.05	0.737	2.240	4.40	0.507	
Sungai Sarawak Kiri													
Kpg Landeh	1.531	1.20	1.276	1.613	5.25	0.307							

Figure 6: Estimation of Rise and Spread of Floodwater

For low flow analysis, there is no critical time of dry season found. The volume of available water from the selected locations of Git and Buan Bidi are enough to provide water for the water demand in the basin.

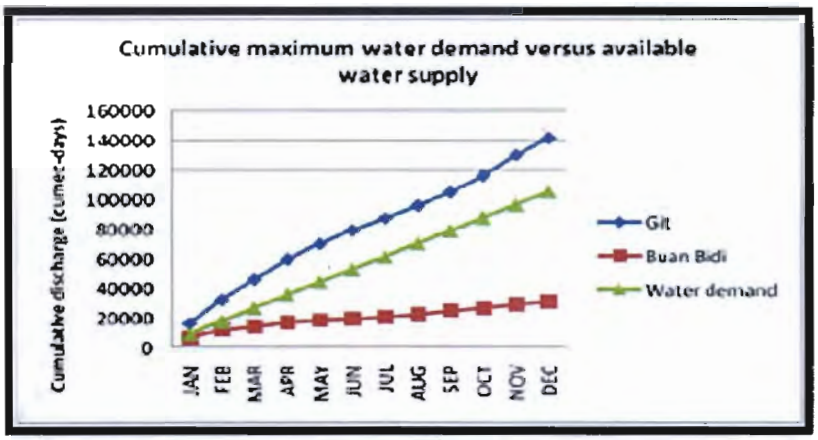
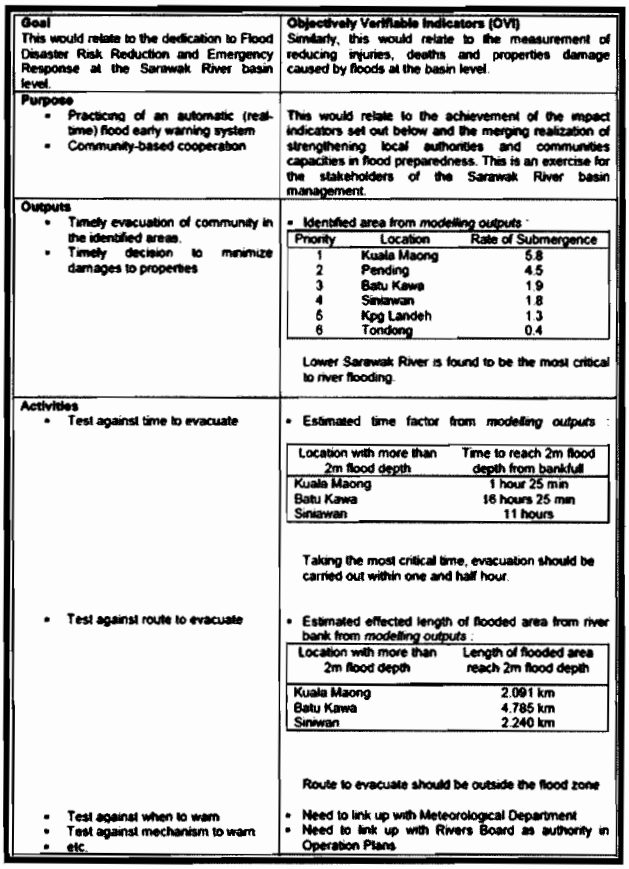


Figure 7: Cumulative Maximum Water Demand Compares with Available Supply

Finally, Logical Framework approach was demonstrated as the designing tool for outlining a proposed framework for achieving the Integrated River Flood Management settings and objectives of a collaborative network among responsible agencies. Fig. 8 shows a sub-logical framework for flood warning system which is part of a larger framework for Integrated River Flood Management.



Goal
This would relate to the dedication to Flood Disaster Risk Reduction and Emergency Response at the Sarawak River basin level.

Objectively Verifiable Indicators (OVI)
Similarly, this would relate to the measurement of reducing injuries, deaths and properties damage caused by floods at the basin level.

Purpose
- Practicing of an automatic (real-time) flood early warning system
- Community-based cooperation

This would relate to the achievement of the impact indicators set out below and the merging realization of strengthening local authorities and communities capacities in flood preparedness. This is an exercise for the stakeholders of the Sarawak River basin management.

Outputs
- Timely evacuation of community in the identified areas.
- Timely decision to minimize damages to properties

- Identified area from *modelling outputs* :

Priority	Location	Rate of Submergence
1	Kuala Maong	5.8
2	Pending	4.5
3	Batu Kawa	1.9
4	Siniawan	1.8
5	Kpg Landeh	1.3
6	Tondong	0.4

Lower Sarawak River is found to be the most critical to river flooding.

Activities
- Test against time to evacuate

- Estimated time factor from *modelling outputs* :

Location with more than 2m flood depth	Time to reach 2m flood depth from bankfull
Kuala Maong	1 hour 25 min
Batu Kawa	16 hours 25 min
Siniawan	11 hours

Taking the most critical time, evacuation should be carried out within one and half hour.

- Test against route to evacuate

- Estimated effected length of flooded area from river bank from *modelling outputs* :

Location with more than 2m flood depth	Length of flooded area reach 2m flood depth
Kuala Maong	2.091 km
Batu Kawa	4.785 km
Siniawan	2.240 km

Route to evacuate should be outside the flood zone

- Test against when to warn
- Test against mechanism to warn
- etc.

- Need to link up with Meteorological Department
- Need to link up with Rivers Board as authority in Operation Plans

Figure 8: Sub-logical Framework for Flood Warning System

Papers/publication related to this project:

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Development of an Efficient Hybrid Solar Thermoelectric-Adsorption Cooling System

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Adsorption and thermoelectric cooling systems are some of the cooling systems available around the globe. Solar adsorption cooling system has witnessed an increasing interest in many fields due to its quietness, durability, low maintenance as well as being environmentally benign [1-3]. Solar thermoelectric cooling however utilizes the conversion of solar energy to electrical energy by means of photovoltaic cells to power up the cooler. Unlike many available works, in the present project, a novel hybrid solar thermoelectric-adsorption cooling system (see Fig. 1) was designed and developed [4]. In a typical experimental study [5], the coefficients of performance (COPs) of the system were determined using derived equations, where the average COPs of the overall system were about 0.131 (adsorption) and 0.152 (thermoelectric), respectively.

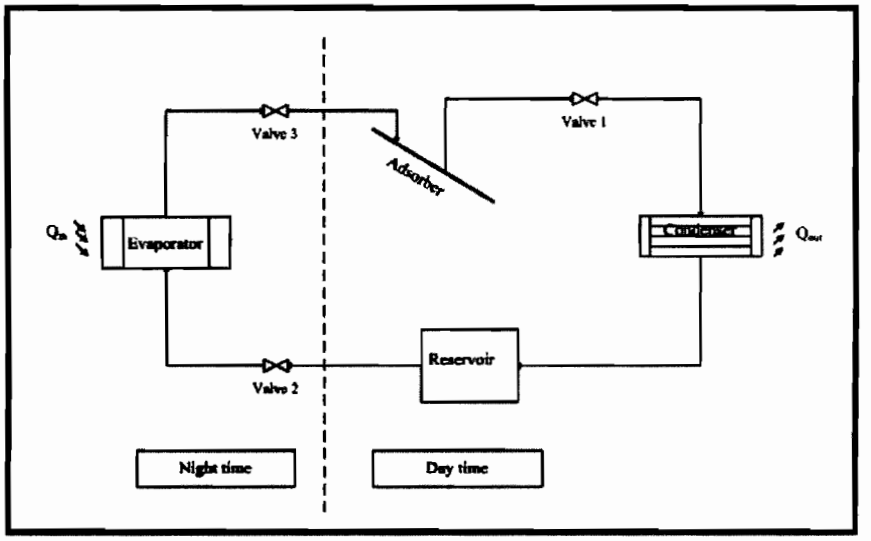

Figure 1: Schematic Diagram of the Hybrid Cooling System

Acknowledgement

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Dielectric Barrier Discharge (DBD) Plasma Actuator for Fluid Flow Control

A.R.H. Rigit, I. Dakek, K.C. Lai and D.B.L. Bong

Since decades, plasma science is a field of growing interest. Plasma, which defines the ionized state of gases, has become increasingly important for various industrial applications [1]. The device in-used, plasma actuator is named after its ability to establish the electric wind or ionic flow. There are two most-used actuators, namely corona discharge plasma actuator and dielectric barrier discharge (DBD) plasma actuator [2]. Dielectric barrier discharge (DBD), which also known as surface DBD (SDBD) has been widely used for the industrial applications and aerodynamic flow control [3-4]. It is a nonthermal discharge under atmospheric pressure that can generate UV emission and low-temperature plasma in the air. The discharge is performed at the surface of a dielectric layer between several electrodes mounted flush at both sides in an asymmetric configuration. The experimental layout and essential connections is shown in Fig. 1.

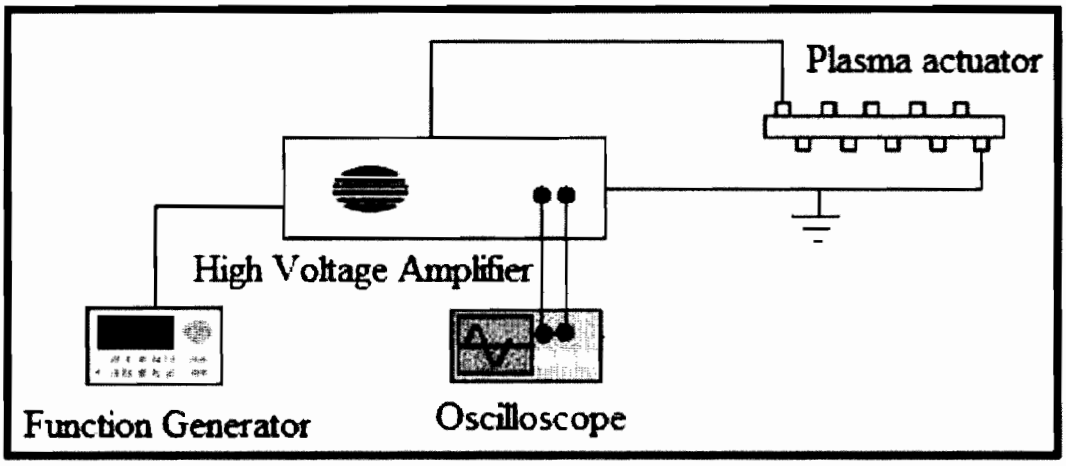

Figure 1: Experimental Setup

The DBD proceeds in most gases or atmospheric air through a large number of separate current filaments referred to as microdischarges. Microdischarges have complex dynamic structure and are formed by channel streamers that repeatedly strike at the same place as the polarity of the applied voltage changes, appearing to the eye as bright filaments [5]. Charge accumulated on the surface of the dielectric barrier reduces the electric field at the location of a microdischarge, resulting in current termination within tens of nanoseconds after breakdown.

Papers/publication related to this project:

[1] Rigit, A.R.H., Lai, K.C. and Bong, D.B.L. (2009). Electrical performance evaluations for a dielectric barrier discharge plasma actuator. IEEE Annual Conf. Report on Electrical Insulation and Dielectric Phenomena, Virginia, USA, Paper No.168. ISBN 978-1-4244-4559-2. Library of Congress 79-649806.

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Estimation of Parking Pricing Model to Mitigate Congestion in Congested Business Districts

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In many cities around the globe, Transportation Demand Mannagement (TDM) has been implemented to aleviate the impact of congestion, air polution and safety problem. As the TDM's supply strategy (adding capacity) alone could not solve the problem, demand strategy in the forms of incentives and disincentives has been used with the aim to modify travel habits (e.g. shift to public transport, change to other destinations, change the trip timing of day and change or cancel trips). These include congestion pricing, parking pricing and restrictions on vehicle ownership use. Past research revealed that free parking at work does have a consistent effect on commuter mode choice whereby it invites commuters to drive to work alone. In this regards, by ending the employer-paid parking, the number of solo drivers can be reduced significantly, and consequently resulting in a considerable reduction in the number of private car commuters driving to work workplaces. In addition, a significant increment in parking pricing at the workplace and commercial centres can significantly reduce the probability of driving alone to work/shop and increase the share of carpooling and public transport users.

Many of the parking facilities in workplace and commercial centre in Malaysian major cities are currently free of charge and in some business district areas; only minimum parking fees are imposed. Such scenarios have attracted more private car commuters to drive alone, and as a result, the current parking pricing policy is no longer effective at mitigating urban congestion. This research aimed to estimate the impacts of improved parking pricing and policy on private car users in an attempt to mitigate congestion in the business district areas. Stated-preference survey was employed for data collection, in which 1199 completed questionnaires have been collected, and subsequently data reduction was undertaken for further analysis using NLOGIT software. The findings from this research could provide a framework on how to undertake a parking pricing review, as well as providing a strong evidence for the improvement of parking pricing policy as one of the effective tools to mitigate urban congestion.

Papers/publication related to this project:

[1] Kabit, M.R., Mansyur, R., Wan Ibrahim, W.H. and Chan, R.A. (2008). Assessing parking pricing impacts on the traveler's choices. In: 2nd Regional Engineering Conference (EnCon 2008), 18-19 December 2008, Kuching.

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Mapping of Tidal Energy for Sarawak

Andrew R.H. Rigit

The seas around the world are a bountiful source of power. The ocean power (or marine power) has drawn a number of researcher's attention since it is a reliable source of renewable energy. This energy needs no fuel and produces no greenhouse gases or other wastes to the environment. Marine power can be classified into two types, namely wave energy and tidal energy. Waves are created by the interaction of wind with the surface of the sea, and they have the potential to provide an unlimited source of renewable energy. Wave energy can be extracted and converted into electricity by wave power machines. They can be deployed either on the shoreline or in deeper waters offshore. However, this study will look into another group, tidal energy, as it is more predictable than wave and wind. Tidal energy exploits the natural ebb and flow of coastal tidal waters caused principally by the interaction of the gravitational fields of the earth, moon and sun. Due to these gravitational forces, water levels follow periodic highs and lows. Associated with these water level changes, there are tidal currents. The tidal energy generator uses this phenomenon to generate energy. The stronger the tide, either in water level height or tidal current velocities, the greater the potential for tidal energy generation.

Progress:

Tidal power can be extracted with two techniques, namely tidal barrage and tidal stream. Tidal barrages make use of the potential energy in the difference in height (or head) between high and low tides, while tidal stream making use of the kinetic energy of moving water to power turbines. Tidal stream method is gaining in popularity because of the lower cost and lower ecological impact compared to barrage. This study aims to investigate the potential coastal areas around Sarawak state for generating the tidal energy, which is one of the renewable energy. An energy mapping methodology is carried out to determine these possible sites and appropriate technology for the generation by using the admiralty charts. Admiralty charts are the world standard for marine navigational mapping. These charts contain relevant information such as tidal flow, shipping routes, fishing areas, and telecommunication areas. Moreover, the detailed depth contours and geological information of seabed enable us to generate complete bathymetric profiles including surface roughness for generating a velocity distribution for the sites of interest. Fig. 1 below shows an admiralty chart of the cruise terminal of Langkawi, Malaysia.

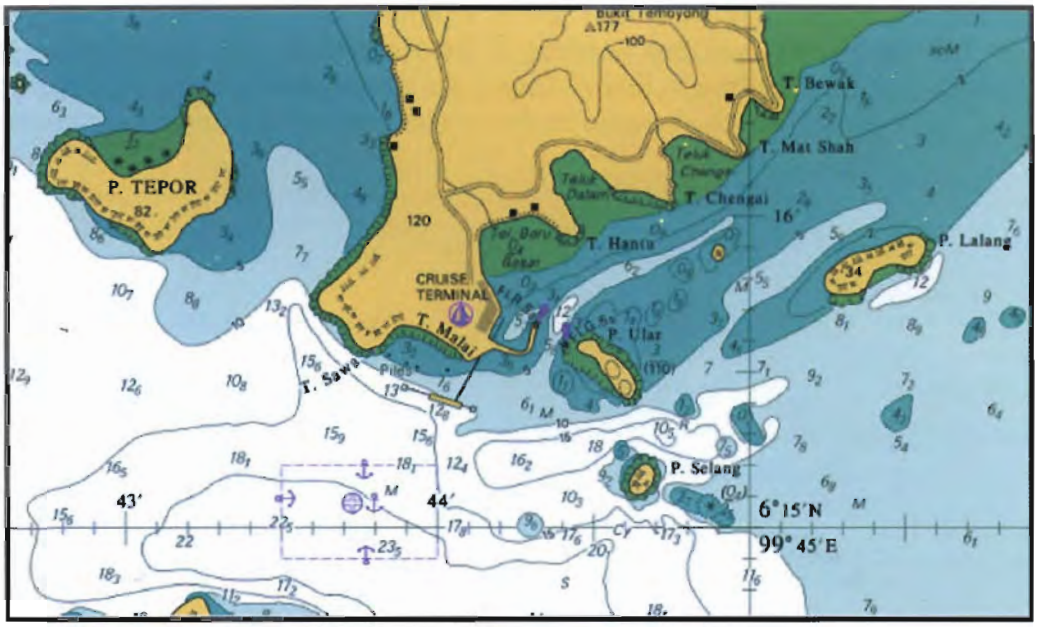

Figure 1: Admiralty Chart of the Cruise Terminal of Langkawi, Malaysia

Roadside Interview and Screen Line Survey-under Highway Planning Unit and Perunding Atur Sdn Bhd

Wan Hashim Wan Ibrahim, Larry Silas, Ron Aldrino and Zamri Bujang

The study was conducted in May 2009 with ten locations covered throughout Kota Samarahan and Kuching areas. The main objective of the survey was to determine the total trip generation and distribution in Kuching and Kota Samarahan regions. The total cost of this study was RM20 thousand and involved ten students, four technicians and three lecturers. We were assisted by police officers from various police stations who gave us the support by controlling the traffic flow. The study was successfully completed in a duration of one week. The survey data was sent to Atur Trafik for analysis and this data will be useful for the development of highway network model.

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